ANNUAL PROGRESS REPORT

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PART 1 SPOTTED OWL HOME-RANGE SIZE AND COMPOSITION IN THE SIERRA NATIONAL FOREST.

PART 2 DEMOGRAPHY OF SPOTTED OWLS IN THE SIERRA NATIONAL FOREST AND SEQUOIA/KINGS CANYON NATIONAL PARKS.

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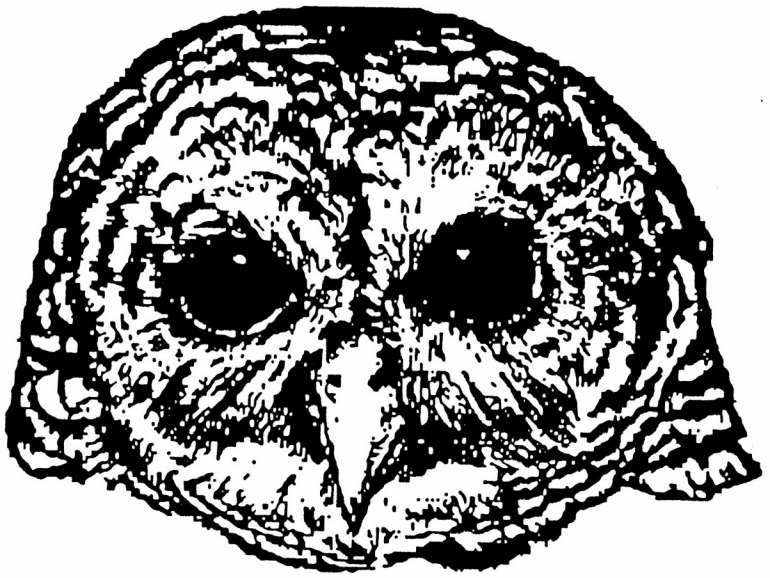

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INTRODUCTION

This report summarizes key activities and results of field studies of Spotted Owls in the Sierra National Forest (SNF) and Sequoia/Kings Canyon National Parks (SNP) during 1990. Part 1 summarizes key results of a study of home-range size, use, and composition (habitat types, vegetational attributes, etc.), using data from radio-tagged owls accumulated up to 28 February 1990. This produced a full year's database on radio-tagged owls in our foothill woodland home ranges, so this study was terminated. Preliminary results from previous years of this study are given in our annual reports for 1987, 1988, and 1989 (Neat et al. 1988, 1989, and 1990).

Part 2 gives preliminary results from two demographic studies, one in SNF and the other in SNP, that were initiated in March of 1990. One objective of these studies is to allow comparisons between Spotted Owl demographics in a managed National Forest and protected forests of the National Parks. Our current planning calls for these studies to continue for at least 7 more years, contingent upon funding.

Results reported here must be treated as preliminary. By its very nature, an annual report must be done by a deadline that sometimes precludes peer review and thorough consideration of all results. Such is the case with this report and all previous annual reports on our research on Spotted Owls in the Sierra Nevada. More detailed and more extensive analyses need to be done on the data from all years before we can prepare a final, definitive report on the various parameters of Spotted Owl biology and ecology investigated in these studies.

PART 1: SPOTTED OWL HOME-RANGE SIZE AND COMPOSITION IN THE SIERRA NATIONAL FOREST

Objectives and methods of this study were described in Neal et al. (1988, 1989, and 1990). Here we briefly summarize some key results that we believe are important for the management of Spotted Owls in the Sierra Nevada. No new captures were made for the radio-tracking study during the fall or winter of 1989. Our primary objective was to accumulate radio locations for a full year on a subset of radio-tagged owls that had home ranges in the foothill woodlands but for which we still lacked data for a full year.

RESULTS AND DISCUSSION

RADIO LOCATIONS

We continued to monitor 18 individual owls, 10 at high elevation and eight in low-elevation oak woodland, during the 5-month period from 1 October 1989 to 28 February 1990, or until their transmitters failed. At the study's end we were monitoring 11 owls, six at high elevation and five at low elevation (Fig. 1). We accumulated another 969 locations, bringing the total for the 4-year study to 6,620 on 33 birds. We obtained 614 winter locations on oak-woodland birds to establish winter home-range sizes. Perhaps the most significant finding of the 1989 and 1990 radio-tracking study was confirmation of yearlong occupancy and breeding by Spotted Owls in oak-woodland habitats in the western foothills of the Sierra Nevada.

MIGRATION

In the winter of 1989-90, we documented one owl migration to the oak-woodland type from the conifer-forest type. This bird, the Stevenson Female, migrated to the same winter range in the oak woodlands that she used in earlier years, a straight-line distance of 15 mi (24.0 km) from her summer home range, sometime in November of 1989 (the exact date is unknown because her radio transmitter was not operating). In the winter of 1990-91 we again identified the Stevenson Female on the winter range in the same area, making this the fourth year she migrated to the same location.

HOME-RANGE SIZE

Winter home ranges in the coniferous forest in 1989-90, for individual birds classified as residents, averaged 2,721 acres (1,100 ha), similar to estimates reported for 1987-88 but considerably smaller than reported for 1988-89 (Table 1). As in previous years (Neal et al. 1988, 1989, and 1990), we have continued to observe much variability in winter home ranges of Spotted Owls in the conifer zone, with most pairs breaking up, and individual birds either migrating, occupying nearly the same home range in winter as in summer, enlarging their home range in winter but still using most or all of the summer home range as well, or shifting their home range for the winter but still overlapping a portion of the summer home range. Overall for the 21 owls radio-tagged in the coniferous forest, six were classified as year-round residents, two as enlargers, five as shifters, five as migrators, and three as unknown (Table 1). In most cases we were unable to determine winter home-range sizes of pairs for coniferous forest birds, mainly because members of pairs moved independently of each other and often did not share areas of use. No new information was obtained on home-range size of birds that migrated from the conifer-forest zone to the oak woodlands because of radio failure.

Winter home-range sizes of six individual oak-woodland owls with more than 35 observations ranged from 183 acres (75 ha) to 1,330 acres (540 ha) and averaged 712 acres (290 ha) (Table 2). This is only 24% as large as the area used by the resident coniferous-forest birds during the same period, and parallels results of summer home-range comparisons between owls in oak woodlands and owls in coniferous forests (see annual report for 1989).

Winter home ranges of two pairs in the oak woodlands in 1989 were 673 acres (Camp 4-1/2 Pair) and 943 acres (Kirch Flat Pair) (mean = 805 acres, or 325 ha) and the area shared by pair members averaged 261 acres (105 ha), or 32.4% of the combined area for the pairs. This was considerably less overlap than observed during the summer period, a pattern duplicated by birds in the conifer forest and consistent with our belief that pair members generally are more independent of one another during the winter than during the summer.

MORTALITIES

Two of our radio-tagged birds died between 30 September 1989 and 28 February 1990. Both were males in the oak woodlands whose mates had died in mid-summer. The Linda Creek Male was found dead on 8 January 1990, 237 days after capture and fitting of the radio transmitter. We believe he successfully fledged one of two young in 1989. The Sycamore Male, a nonreproductive subadult, died in early December after carrying his radio for 195 days. A large wildfire burned the extreme north edge of the Sycamore pair's home range the previous August. We do not know if this owl's death was related to the fire.

In the 3 years of study, we have radio equipped 33 individual birds; 11 of those have died (Table 3). Five of the deaths occurred within 50 days after attaching

transmitters for the first time or attaching replacement transmitters. The six other dead birds carried radio transmitters for an average of 180 days with no known problems prior to death. We lack sufficient information to conclude that these birds died from stress related to handling or to improperly attached transmitters.

The ratio of deaths to captures is higher in the oak woodlands (5 of 12 = 42%) than in the coniferous forest (6 of 21 = 29%) (Table 3). Of the 11 deaths, four were captured as subadults--two in the oak woodlands died 49 and 195 days after handling and two in the coniferous forest died 332 and 224 days after handling. The ratio of female to male deaths was 6:5 overall--3:2 in the oak-woodland and 3:3 in the coniferous forest. The relation between death date and handling date of male or female owls was not statistically significant ($P = 0.31$; ANOVA).

DIET

The collection of cast pellets continued as in previous years; approximately 1500 pellets have been collected altogether. All pellets collected in 1989 and 1990 have been analyzed and data are currently being computerized. Collections in 1989 were concentrated in the periods and areas where previous samples were the smallest--coniferous forest in winter and oak woodland in summer.

HABITAT DESCRIPTIONS

As in 1987 and 1988, each seasonal home range was delineated using the minimum convex polygon method (MCP) and divided into habitat-type polygons using aerial photos and ground checks. All mapping and digitizing of home ranges into D-WRIS has been completed for all years. Combining output from this system with radio-location data, using the UTM mapping system, allows observations to be assigned to habitat polygons and habitat-use analysis (chi-square tests) to be run on all radio-telemetry data.

On-the-ground transect measurements of components of each polygon were begun for the conifer-forest home ranges during the summer of 1989. These measurements, and comparable ones in the oak-woodland habitats, have been completed for all home ranges and all habitat types.

Habitat use in relation to canopy cover. Based on classification of habitat polygons into three canopy-cover classes (0-39%, 40-69%, and 70+%), we have tested for significant departures in owl use of habitats in relation to availability. Details of these analyses are given in Neal et al. (1988, 1989, and 1990) and in Tables 4-8. In all years, the owls' summer use of habitats showed a significant ($P < 0.05$; chi-square test) overuse of the 70+% canopy-cover class. Their use of areas with 40-69% canopy-cover was as expected based on availability, and their use of polygons with 0-39% canopy cover was significantly less than expected in all cases. This was also true for the oak-woodland winter home ranges of single (Table 4) and paired owls (Table 5) and winter home ranges of paired owls in the conifer-forest type (Table 7).

Winter habitat use by individual, resident owls in the conifer forest, however, was an exception to the above findings (Table 6). Habitat use did not differ significantly from expected in relation to the three levels of canopy closure. The same was true of the overlap between the winter home ranges of the Exchequer Male and Exchequer Female (Table 7).

The above results, based on only three canopy-cover classes, tend to obscure where within the 40-69% cover category the owls tend to use habitats more than

expected in relation to canopy cover. To obtain a finer assessment of this question, we have evaluated habitat use by 10-percentage intervals (0-10%, 11-20%, etc.). Based on data pooled across 1987, 1988, and 1989, we would expect 0.029 location of radio-tagged owls per acre in each canopy-cover class. Observed locations per acre fell below that expectation for all cover classes up through 41-50% and above that expectation for all cover classes greater than 50% (Fig. 2). This suggests that suitable Spotted Owl habitat in the Sierra Nevada generally has a canopy cover in excess of 50%.

Owl home-range sizes and characteristics compared to management guidelines. Summary statistics on total home-range sizes and areas by canopy-cover class (Tables 9-11) indicate that the areas used by Spotted Owls in the conifer zone of the Sierra National Forest tend to be considerably greater than provided by the Regional Standards and Guides for management of Spotted Owls in California in general. For example, a SOHA that meets the Standards and Guides provides 1000 acres of suitable habitat for a pair of Spotted Owls, plus 650 acreas of "replacement" habitat. The 1000 acres is only 37.4% of the total home range of individual birds during the summer season, 28.0% of the total for pairs during the summer season, and 16.9% of pairs over a full year (Table 11). Similarly, the 1000 acres in a SOHA is only 51.5% of the amount of forest stands of 40% or greater canopy cover observed in summer home ranges of individuals, 39.5% of that in summer home ranges of pairs, and only 20.2% of that in yearlong home ranges of pairs (Table 11).

In spite of the above comparisons, we cannot definitely conclude that SOHAs in the Sierra National Forest are presently inadequate for Spotted Owl pairs. "Suitable habitat" according to Regional Standards and Guides is generally older forest with 70% or greater canopy cover. It is entirely possible that other stands with 40-69% canopy cover presently exist near SOHAs, bringing the total area available to owl pairs in SOHAs up to the nearly 2000 acres observed in this study. (But such habitat is not now designated for retention in SOHAs to provide for the owls.) On the other hand, many SOHAs apparently lack sufficient habitat even to meet Regional Standards and Guides. Clearly, each SOHA needs to be re-evaluated in terms of these results. And we need to be thinking more in terms of 50% canopy cover as a basis for characterizing suitable habitat for Spotted Owls, at least for foraging. Canopy cover of at least 70% appears to be an appropriate level for characterizing suitable roosting and nesting habitat.

Characteristics of vegetative types. We completed preliminary analyses of vegetation sampled in coniferous forest sites in 1990. One hundred twenty polygons were sampled, using four randomly located, 100-m strip plots per polygon. In vegetative types represented by four or fewer polygons, all were sampled; otherwise four polygons of a given vegetative type were randomly selected from among all polygons of that type in owl home ranges. In five cases, vegetative types were changed or polygons were combined after sampling was completed. This resulted in deviation from the prescribed four-polygon sample. Vegetative descriptions reported here resulted from the pooling of 48 vegetative types (Table 12) into 11 forest timber classifications (Table 13).

Major structural components of the 11 forest timber types are summarized in Table 14). Canopy-cover estimates based on aerial photos and densiometer readings were significantly correlated ($r = 0.86$; $P < 0.001$). The densiometer estimates, however, averaged 4.9% (SD = 12.8%) higher than those from aerial photos, because densiometer readings include some shrub canopy above breast height and also tree trunks lateral to the observer; they may also include

canopy cover from neighboring polygons. These differences should be allowed for when estimating canopy cover in stands intended for Spotted Owl habitat.

Percent canopy cover was significantly correlated with basal area (ft^2/acre) of live conifers (r = 0.82; $P < 0.001$). As expected, basal area was highest in polygons with high canopy cover (70+%), intermediate in polygons with medium canopy cover (40-69%), and lowest in polygons with low canopy cover (0-39%). Similar results held for canopy cover and tree density (Table 14).

PART 2--DEMOGRAPHY OF SPOTTED OWLS IN THE SIERRA NATIONAL FOREST AND SEQUOIA AND KINGS CANYON NATIONAL PARKS

INTRODUCTION

Two demographic studies were initiated in March, 1990, that will continue for a minimum of 7 years, contingent on continued funding. One study area (SNF) overlaps the area used in the Sierra National Forest for home-range analyses reported in Part 1. The other (SNP) overlaps the area used in Sequoia/Kings Canyon National Parks for a preliminary investigation of demography (Roberts 1989). Consequently, we already have considerable information on the Spotted Owls of both study areas upon which to base larger, more complete demographic studies.

STUDY AREAS

SIERRA NATIONAL FOREST

Boundaries of study areas (Fig. 3) were delineated on major topographic features such as ridges, drainages (major rivers), and administrative units. The SNF study area covers 161 mi^2 (419 km^2) in three habitat zones (Table 15) in the southern Sierra Nevada, approximately 50 miles (80 km) east of Fresno, California.

1. The oak-woodland type, at the lowest elevations--1,000 to 4,000 feet (305 to 1,220 m)]--encompasses 50 mi^2 (130 km^2); the canopy is dominated by blue oak (Quercus douglasii), live oak (Quercus wislizenii), and digger pine (Pinus sabiniana). Various foothill chaparral species are abundant.

2. The mid-elevation coniferous forest--from 4,000 to 8,000 feet (1,220 to 2,438 m)--occupies 96 mi^2 (251 km^2). Vegetation at 4,000 to 5,000 feet (1,220 to 1,525 m) is dominated by ponderosa pine (Pinus ponderosa), white fir (Abies concolor), incense cedar (Calocedrus decurrens), and black oak (Quercus kelloggi). Sites from 5,000 to 8,000 feet (1,525 to 2,438 m) are dominated by white fir, Jeffrey pine (Pinus jeffreyi), incense cedar, red fir (Abies magnifica), and sugar pine (Pinus lambertiana). Nearly all of this zone was logged between 1880 and 1930 and most of the trees remaining today were unmerchantable due to size, species, or inaccessibility at that time. Timber harvest has continued on National Forest land and private holdings at a much reduced rate since 1930; only small, scattered patches of old-growth remain. Forest regeneration programs are in place on both public and private lands. Nearly all logging has been some form of selective

cutting; the little clearcutting that has taken place has been in scattered patches typically <20 acres (8 ha).

3. The high-elevation coniferous forest--8,000 to 9,600 feet (2,440 to 2,925 m)--covers 15 mi^2 (40 km^2). This zone is dominated primarily by lodgepole pine (Pinus contorta) and western white pine (Pinus monticola).

SEQUOIA/KINGS CANYON NATIONAL PARKS

The SNP study area is also in the southern Sierra Nevada, 15 miles (25 km) south of the SNF study site and approximately 50 miles (80 km) east of Visalia, California (Fig. 3) It covers 132 mi^2 (343 km^2), and it has also been divided into three different habitat zones (Table 15).

1. The oak-woodland type covers about 32 mi^2 (83 km^2) and ranges in elevation from 1,000 to 4,000 feet (305 to 1,220 m). Vegetation is similar to that in the same elevational zone of the SNF study area, with the exception of having more chaparral in large, uniform blocks on slopes facing southwest.

2. The mid-elevation coniferous forest types occupy 89 mi^2 (230 km^2) and range in elevation from 4,000 to 8,000 feet (1,220 to 2,440 m). Vegetation in this zone is similar to that in the SNF study site, although SNP includes large stands of giant sequoia (Sequoiadendron giganteum) and large tracts of old-growth mixed-conifer forest. Some logging occurred in this zone in the late 1800s and early 1900s, but most stands are currently in mature or old stages of growth.

3. The high-elevation coniferous forest type occupies 11 mi^2 (30 km^2) and ranges in elevation from 8,000 to 9,000 feet (2,440 to 2,745 m). The vegetation in this zone is the similar to that in the SNF study area.

OBJECTIVES

1. Estimate densities of Spotted Owls and occupancy status of owl territories in the designated study areas.
2. Estimate vital rates (reproduction, mortality), by age class.
3. Assess site fidelity among individual Spotted Owls.
4. Estimate turnover rates (reoccupation of territories vacated during the study period).
5. Quantify the distribution of vegetative habitats within the study area.
6. Characterize diets of Spotted Owls from regurgitated pellets, and compare diets of breeding and nonbreeding pairs during the breeding period (1 March to 30 September).

METHODS

We attempted to locate, capture and color band all Spotted Owls within both demographic study areas. Potential owl locations were surveyed during both day and night, using vocal imitations to elicit responses. Methods included point calling, leap-frog road surveys, and walking cruises.

SURVEY EFFORT

We systematically surveyed all areas until an owl responded or, if no response was detected, until six complete visits were done. We attempted a minimum of four night visits per area, with visits spaced at least 4 days apart. At least two of the night visits were done before 30 June. Where night access was determined to be hazardous, visits were made during the day, but we tried to visit the site just prior to sunset or just after sunrise when birds were still active. Nighttime visits were done between sunset and sunrise, and we endeavored to not call the same section of a surveyed area at the same time of day on different visits.

We did not survey under inclement weather conditions, such as high winds or steady rain, that may have prevented our hearing a response. Water noise was another factor we considered when surveying drainages.

One complete visit was defined as covering an entire delineated area, for a minimum of 10 minutes of calling time. We selected calling methods to ensure that our calls were audible in all parts of the survey area regardless of the habitat type. For historic locations, we began the survey route at the calling point nearest the center of activity or nest tree. At other areas, we picked a logical starting point.

Surveys began on 1 March and ended on 30 September. Pair, nesting, and reproductive status were verified as follows:

SOCIAL STATUS.

Pair status. Pair status was established by any of the following:

1. A male and female were observed <1/4 mi from each other, or one bird vocalized and the other was seen, or a male and female vocalized back and forth <1/4 mi from each other on two or more occasions at least one week (7 days) apart.

2. One observation of a male taking a mouse to a female, or a female was detected (heard or seen) on a nest.

3. One observation of one or both adults with young.

4. One observation of a previously marked pair of owls, confirmed by direct observation, in their historic roost.

Single status. Single status was established by the presence or response of a single owl for a specific area (e.g., historic owl location) on two or more occasions within the breeding (including fledgling) period (1 March to 31 Aug.), with no response by an owl of the opposite sex after six complete visits.

Status unknown. Unknown status was established by the response of a male or female that did not meet pair or single status.

NESTING STATUS/NEST TREE LOCATION

Nesting. Nesting was established between 1 March and 1 June if:

1. A female was detected (heard or seen) on the nest, either member of a pair carried prey to the nest, or a combination of these was observed two or more

times, spaced at least 1 week apart between 1 March and 1 June. If this activity was observed after 1 May, then one observation was sufficient.

2. A female possessed a brood patch when examined (between mid-March and mid-June).

3. Young were detected in the presence of one or both adults (may not be able to I.D. the nest tree).

Non-nesting. Non-nesting was established between 1 March and 1 June if:

1. The female was observed roosting for extended periods (greater than a half hour) on at least two visits between 1 March and 1 June. Visits were spaced such that the first and last were at least 3 weeks apart to ensure that the observation period was sufficient to witness a late nesting attempt.

2. The female did not possess a brood patch when examined in hand from mid-March to mid-June.

3. Four mice were offered to one or both members of the pair and one or both took at least two mice, but did not deliver them to a nest on two or more visits between 1 March and 1 June.

All pairs classified as non-nesting received at least one follow-up visit during late May or early June. At that time they were offered at least four mice to further verify non-nesting status.

Unknown nesting. If nesting status was not determined before 1 June, and young were not detected, the owls were classified as "unknown nesting status with fledging status unknown."

Nesting effort failed. A nesting attempt was classified as failed if the pair was initially classified as nesting but, on repeated visits and offering of prey, one or both of the pair cached the prey, sat with the prey, or refused to take the prey. Also, if the nest was known to have been destroyed or disturbed and the adults abandoned the nest, the nesting was classified as failed.

Reproductive success. Reproductive success was determined by returning to the nest site as the young left the nest, usually in late May to mid-June. We made two or more visits to the site to find and count the young fledged, timing our visits so that the young were observed as soon as possible after leaving the nest, usually between 15 May and 15 July. Data gathered during this period were used to determine the maximum number of offspring fledged. Any data gathered after the cutoff date were used to calculate reproductive survival. Sampling was similar to the nesting survey.

We offered at least four mice to one or both members of a pair on two different occasions, separated by at least 1 week. The sight of an adult with prey usually stimulated the young to beg, revealing their location and number. Usually at least one follow-up visit was done 3-10 days after the young were first seen, because it was possible to miss some owlets on the first visit. If we did not meet the above criteria, we classified the production of young as unknown.

All new crew members were assigned to work with experienced owl callers to receive training on calling, capturing, and handling owls and to learn the geography of the study area. Capture techniques used during the demography study were similar to those used during the home-range/radio-telemetry study. All owls that were captured were fitted with two bands--one U. S. Fish and Wildlife Service locking, aluminum leg band on the right tarsometatarsus and a plastic color-coded band with a separate, colored tab on the left tarsometatarsus. Fledglings were banded with a U. S. Fish and Wildlife Service band and a colored band designated for 1990 (orange with white stripe in the middle).

Capture locations and roost or nest sites were plotted on maps using UTM coordinates. Sex and approximate age of owls encountered were determined by pitch of voice, calling behavior, and plumage. Age categories were: nestling, juvenile, subadult, and adult. Nestling and juvenile owls were not sexed.

Turnover. Owls marked with colored bands were observed to determine turnover rates on sites. To verify a colored band, two observers independently observed the bird, determined the color combination of the band and tab, then compared notes. In cases of disagreement between observers, each continued to observe the owl until agreement was reached. Three general outcomes were possible:

1. The presence of previously marked owls was confirmed by direct observation.

2. Turnover of a previously marked owl was established by:
   A. Replacement by another owl of the same sex at the site, with no observation of the previously marked bird.
   B. Observation of a marked owl at a different site.
   C. Recovery of the carcass of the owl or other confirmation of death.
   D. Absence of the marked owl, as determined, by using standards for status (six visits/year) for a period of 2 years.

3. Any case not meeting either condition 1 or 2 was classified as undetermined.

VEGETATIVE MAPPING AND SAMPLING

Mapping techniques and vegetation sampling from the habitat as a whole and for nest trees will be developed in the winter of 1990-91 for the demographic study.

PRELIMINARY RESULTS AND DISCUSSION

SURVEY

Calling surveys began at the low-elevation sites in the SNF study area on 1 March 1990, then moved higher in elevation as weather and road conditions permitted. By 15 April, crew size increased to six on the SNF site, but that of the SNP site was only two. We had to delay the survey and capture effort on the park study to obtain permits and locate adequate housing for field crews. Surveying on the SNP site began on a limited basis on 6 March.

No areas within the study sites were initially assumed to be without owls, regardless of vegetation type, slope, aspect, or elevation. The survey effort went as expected, with 79% of SNF and 72% of SNP being called at least once by 27 September (Figs. 4 and 5). Calling the remaining areas and recalling of some sites was hampered by lack of time and the number of owl responses that were

recorded in the first calling session. Follow-up calling to capture, band, and determine status of owls accounted for most of the return visits.

Our visitation log shows that we called about 33% of both study sites three times but only 8% of SNF and 15% of SNP six or more times (Figs. 4 and 5). The lack of roads and trails in SNP impaired our ability to cover much of that study site, and the noise from rivers and streams affected some calling efficiency in both study sites until late in the summer. The visit log does not, however, give a good picture of the adequacy of our overall inventory of the study areas. Many pairs are located after a single visit, for example, and most pairs are located after three visits. Because of this, it is not necessarily the case that all parts of the study area need to be visited six times.

DETECTION AND CAPTURE

Sierra National Forest. In SNF in 1990, we located 107 owls--85 adults and subadults and 22 juveniles (Table 16). Sixty-five of the adults were newly identified during 1990 and 20 were birds previously radio-tagged or banded during our home-range study. We captured and banded 36 of the new birds for a total of 56 banded adults and subadults (66% of the total located in 1990). Of the 22 juveniles (young fledged in 1990), 15 (68%) were captured and equipped with colored leg bands specific to this cohort. A grand total of 71 (66%) Spotted Owls were color banded in SNF by the end of the 1990 field season.

Among adults and subadults, 37 pairs were confirmed (Table 16), one unmated male was confirmed, and six males and four females were of unknown status. Boundaries of the SNF study area (Fig. 6) encompassed all adult and subadult owls known to survive from the home-range study done in the Sierra National Forest from spring of 1987 to winter of 1989-90. All were equipped with radio transmitters and Fish and Wildlife Service bands. Ten juveniles that fledged in 1989 were equipped with Fish and Wildlife Service bands and colored bands. Eighteen of the adults and subadults (90%) and two juveniles (20%) from 1989 were accounted for in 1990. We were unable to recapture 15 (83%) of the 18 adults and subadults, mainly because they had been captured as many as three times before and were very "trap shy." Four adults equipped with radio transmitters and eight juveniles banded in 1989 were not relocated in 1990. Recapture success on the SNF should improve as the owls "forget" their previous captures and as we can spend more time on recaptures vs searching for new birds.

Sequoia/Kings Canyon National Parks. We located 88 owls in SNP in 1990--67 adults and subadults and 21 juveniles (young fledged in 1990) (Table 16). Seven territorial owls that were located in an earlier demographic study within our SNP study area (Roberts 1989) were not relocated in 1990. These were the Skagway Grove pair, the Burnt Point Creek female, the Mill Creek female, the Cedar Creek female and the Deep Canyon pair (Fig. 7). The Deep Canyon pair's territory is along the Marble Fork of the Kaweah River, and the noise from the river may have impaired efforts to detect these birds. All sites where previously located birds were not found in 1990 were surveyed only from one to five times, so conclusions about their presence or absence are premature. We located five pairs of owls that had not been found during the Roberts' study, and 12 other adults and subadults were also located in 1990. One of these owls, the Sugar Bowl female, was found paired to a male in an area where only a male was located in 1988, and no owls were detected there in 1989 after a complete survey (C. Roberts, pers. comm.). Of the 11 remaining, newly detected owls, eight were males, and three were females. Pair status of these 11 owls remains unknown.

Twenty-five pairs were confirmed, and 13 males and four females of unknown status were located. Fifteen of the 67 adults and subadults were banded in 1988 and 1989 (Roberts 1989), and 13 adults and two subadults were captured and banded in 1990, totaling 30 adults and subadults banded by the end of the 1990 field season (Table 16). An additional four adults and one juvenile banded by Cindy Roberts in 1988 and 1989 were not relocated in 1990. This gives a survivorship estimate of 79% for adults known from the 1989 field season (see Roberts 1989), but these estimates should be used with caution because we were not able to survey all of the study area as thoroughly as needed.

We captured and placed cohort bands on 15 of the 21 young known to be produced in SNP in 1990. This gives a grand total of 50 owls of all age classes that have been banded on the SNP study area to date. Of the four previously banded owls not identified, Abbott Creek female #1 was never located in 1990; she was replaced in her territory by a subadult female. The Big Springs female, banded in 1988, was also never relocated, though the Big Springs male was located with a juvenile so was obviously paired, and the pair nested in 1990. The Sherman Creek and the Little Deer Creek females, both banded in 1988, were not located in 1990, although paired birds were found at each of their sites.

Late initiation of capture procedures in SNP, the limited number of field personnel, and poor access to a large portion of the study area all contributed to the low number of owls banded in 1990. We expect to improve our capture success in 1991 by increasing field personnel, using pack animals to increase mobility in the park, and by attempting to capture juveniles by climbing nest trees prior to fledging.

DENSITY

For the complete study area and the area surveyed at least once, little difference existed in estimates of crude density between SNF and SNP (Table 16). SNF had more individuals and paired owls per mi^2 below 4,000 feet (1,220 m) than above, which may be explained by our not finding owls above 8,000 ft (2440 m), but this situation will not be clear until ecological densities are calculated next year. In SNP, the reverse situation occurred--higher owl densities were found at higher elevations. The difference between the two study areas may be explained by poor accessibility of low-elevation sites in SNP and the large, uniform blocks of chaparral there. We expect this information to be clarified for both study areas in the future, as not all birds were positively identified this year.

MORPHOLOGICAL CHARACTERISTICS

Seven morphological characters were measured on all owls captured for banding ($n = 91$) on both study areas (Table 17). Variables measured (grams or millimeters) included weight, bill length, bill depth, tarsus length, tail length, wing chord, and the number of complete tail bars. All variables were analyzed using oneway analysis of variance, with an alpha level of 0.05. Each variable was compared by sex and then by sex and elevation together. We used 4,000 feet (1,220 m) as the elevational break, because it approximates the elevation at which conifer-dominated habitats shift to oak-dominated habitats.

Weight was the best indicator of sex (Table 17), as reported by Blakesley et al. (1990) for the Northern Spotted Owl (Strix occidentalis caurina). Owls of both sexes were significantly heavier in low-elevation than in high-elevation sites (Table 18). Whether this represents a genetic or ecotypic difference cannot be

determined with current information. We suspect, however, that it is ecotypic and relates to the smaller home ranges of pairs in the foothills.

MORTALITIES

Sierra National Forest. Nestling/fledgling mortalities were noted in both demographic study areas this year. In SNF, one nestling was found dead below the Bear Creek nest, our only known nest of a subadult female, and both nestlings at the Camp 4-1/2 site disappeared (and were presumed dead) about the time they were expected to fledge. Two other disappearances of note during 1990 in SNF were of adult females that fledged young, one at Upper Rush Creek and the other at Soaproot Flat. Neither female showed signs of deteriorated condition before disappearing, nor did we ever find evidence of their mortality.

The males at each of these sites reared both of their young alone. Fledglings at the Upper Rush Creek site appeared to be healthy, but those at Soaproot Flat appeared smaller and their sternums could easily be felt, as though their breast muscles had atrophied. One was noticeably small. When captured over 80 days after fledging, it weighed only 405 g (about 150 g less than the mean for juveniles at this age) and was never observed again after banding.

Sequoia/Kings Canyon National Parks. In SNP, remains of one nestling were found near the suspected nest site of the Soldier Tree pair. We believe that it died before fledging and that the pair successfully fledged at least one other juvenile this year.

REPLACEMENT

Sierra National Forest. Six radio-tagged owls in SNF were replaced by new owls in 1990. Three of the replacements involved known mortalities and three involved radio-tagged owls that disappeared over the winter. Of the known deaths, the Providence Female died in September 1989 and was replaced approximately 196 days later by another radio-tagged adult--the Bear Meadow Female. The latter bird was paired when first captured in June 1988, but she had not been seen with her original mate since October 1988. She was subsequently observed in the Strawberry site and the Providence site in the summer of 1989. Other known cases of death and replacement in SNF were a pair of subadults that died in 1989 and were replaced by yet another pair of subadults in 1990.

In the three cases of missing adults, one was replaced by a subadult female within 136 days after last being observed. In the two other cases, banded subadults that fledged in 1989 from the Providence Creek site replaced adults at two of the 1987-89 radio-telemetry sites. Providence Fledgling #1 dispersed 3.3 miles (5.3 km) northeast of its natal site and was paired with a radio-tagged adult male at the Reese site. The adult female at the Reese site was last seen 69 days earlier. Providence Fledgling #2 dispersed 4 miles (6.5 km) east of its natal site and was paired with a radio-tagged adult female at the Laurel site. The subadult male at this site was last seen 167 days before replacement. It is interesting to note that, throughout the telemetry study, the Laurel female was paired with a new subadult male in 3 of the 4 years, but she never nested. The fate of only one Laurel male is known; it died after migrating to low-elevation oak woodland in the winter of 1987-88.

A possible seventh replacement--a new subadult male near the Markwood site--was never positively confirmed because we never observed the pair together.

Of the 10 owls replaced in SNF during the radio-telemetry study and the first year of the demographic study, a mean of 139 days elapsed before replacement (range 14 to 297 days). No difference was found between males and females, but replacement of oak-woodland birds took significantly longer than for birds in the conifer forest (234 vs 96 days, respectively; $P = 0.03$; ANOVA). These estimates represent maxima, because replacement in each case occurred an unknown number of days prior to detection.

Sequoia/Kings Canyon National Parks. Only two territorial owls were known to be replaced in the SNP study area between 1989 and 1990. A pair of adults were banded in the Abbott Creek territory in 1989; the owls were difficult to locate in this territory in 1990 and were not seen until late September. In October, both owls were found roosting together and the female was subsequently captured, identified as a subadult, and banded. The banded male was later identified while roosting with the subadult female. A pair of adult owls occupied the Cascade Creek site in 1988 and 1989. The female was banded in 1988 and relocated there in 1989. In 1990 she was found with a subadult male; the fate of the adult male(s) with which she was seen in earlier years is unknown.

REPRODUCTION AND NESTING ATTEMPTS

Sierra National Forest. Eighteen of the 37 pairs of owls located in SNF in 1990 nested (Table 16); five were known not to nest, and the nesting status of 14 pairs was not known. Five of the 18 nesting pairs abandoned their effort and 13 pairs fledged young. Four pairs raised one young each, and nine pairs raised two young each.

Sequoia/Kings Canyon National Parks. Thirteen of 25 pairs in SNP were found with juveniles in 1990 (Table 16). Eight of these pairs fledged at least two young each, and five pairs fledged at least one young each. The nesting status of most pairs not found with juveniles was unknown, mainly because of the late starting date in SNP. Only the Suwanee Creek pair was confirmed not to have nested. Another problem encountered in both study areas was the reluctance of owls to take mice or rats, even on the first encounter with our owl crews. Although this problem does not limit our ability to determine nesting, it does require crews to make extra visits to sites that could otherwise be spent searching for new owls.

OTHER PROBLEMS ON THE SNP STUDY AREA

Of the 15 previously banded owls (Roberts 1988 and 1989) identified in 1990, four (26.7%) were difficult to identify because the tabs attached to the bands were not clearly visible. Three of these owls (the Little Deer Creek male, the Sequoia Creek female, and the Cascade Creek female) were recaptured for positive identification during the course of the field season, and problems with their bands and tabs were corrected. The tab on the Big Springs male was not visible, even though we could clearly see the band, but we were not able to recapture this bird to make any needed band/tab adjustments. Fortunately this owl could be positively identified by band color alone.

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Table 1. Sex (M = male, F = female), status (see footnote), and home-range size (acres) for all radio-tagged Spotted Owls in the conifer-forest study area. Sample size (n) is the number of locations for each bird.

			Summer 1987[1]		Winter 87/88[1]		Summer 1988		Winter 88/89		Summer 1989		Winter 89/90	
Bird	Sex	Status[2]	n	Acres	n	Acres	n	Acres	n	Acres	n	Acres	n	Acres
Bear Mdw.	F	Enlarger	-	-	-	-	65	5121.6	55	4260.3	24	4108.3	-	-
Dinkey Cr.	F	Migrant	123	4516.7	-	-	-	-	-	-	-	-	-	-
	M	Unknown	29	119.8	-	-	-	-	-	-	-	-	-	-
	M2	Migrant	103	3647.4	36	8403.6	28	4605.0	-	-	-	-	-	-
Exchequer	F	Resident	101	1950.1	87	2965.7	12	1551.5	-	-	57	920.7	53	2067.7
	M	Resident	104	2291.6	94	2292.1	3	89.2	-	-	66	2137.4	62	2294.5
Laural Cr.	F	Resident	-	-	-	-	91	2232.8	-	-	-	-	-	-
	M	Migrant	112	2767.3	11	3989.2	-	-	-	-	-	-	-	-
	M2	Resident	-	-	-	-	116	4129.5	63	4173.8	51	1633.8	-	-
Markwood	F	Unknown	11	43.2	-	-	32	252.5	-	-	-	-	-	-
	F2	Shifter	-	-	-	-	35	989.1	24	6497.2	32	1165.1	-	-
	M	Shifter	134	1956.5	96	6176.8	3	217.2	-	-	-	-	-	-
Oak Flat	F	Unknown	-	-	-	-	-	-	-	-	20	1450.0	-	-
Providence	F	Enlarger	103	1395.1	88	7781.7	128	2112.7	55	3119.9	65	1630.1	-	-
	M	Resident	96	2367.7	68	1900.0	16	441.3	-	-	84	3241.5	52	3641.7
Reese Cr.	F	Shifter	-	-	-	-	-	-	-	-	48	2662.7	60	13306.6
	M	Shifter	-	-	-	-	127	2963.0	21	1485.1	56	2433.4	50	14010.3
Stevenson	F	Migrant	37	3408.0	77	2007.2	114	5782.1	71	531.5	53	3154.5	-	-
	M	Shifter	44	1648.9	44	10373.7	26	815.7	-	-	-	-	-	-
Strawberry	F	Migrant	-	-	-	-	99	1819.1	27	292.7	29	486.3	-	-
	M	Resident	117	1569.1	94	4017.1	117	2071.7	-	-	78	1627.6	78	2880.0
Mean[3]				2502.0				3279.0				2160.0		
S.D.				987.0				1537.0				780.0		
Winter mean for residents						2794.0				4173.8				2721.0
S.D.						947.0				-				703.0
Winter mean for shifters						8275.0				-				13658.0
S.D.						2968.0				-				498.0
Winter mean for enlargers						7781.7				3690.0				-
S.D.						-				806.0				-

[1] Summer = 1 March to 30 September; winter = 1 October to 28 February.

[2] Status: Residents stay in the same home range all year; shifters move home ranges between seasons, but winter and summer ranges overlap; enlargers have larger winter home ranges that include their summer home ranges; migrants move between summer home ranges in the conifer forest to winter home ranges in the oak woodlands.

[3] Birds with 35 or fewer observations were not included in home-range means.

Table 2. Sex (M = male, F = female), status (see footnote), and home-range size (acres) for all radio-tagged Spotted Owls in the oak-woodland study area. Sample size (n) is the number of locations for each individual bird.

			Winter 87/88[1]		Summer 1988[1]		Winter 88/89		Summer 1989		Winter 89/90	
Bird	Sex	Status	n	Acres	n	Acres	n	Acres	n	Acres	n	Acres
Camp 4-1/2	F	Resident	-	-	-	-	-	-	88	342.2	101	601.7
	M	Resident	-	-	-	-	-	-	122	326.9	103	183.4
Deep Creek	F	Resident	-	-	6	525.8	-	-	-	-	-	-
	M	Resident	3	0.0	21	54.4	4	1.0	13	19.5	-	-
Kirch Flat	F	Resident	-	-	-	-	-	-	94	704.7	111	753.1
	M	Resident	-	-	-	-	-	-	117	581.7	92	585.2
Linda Creek	F	Resident	-	-	-	-	-	-	20	411.4	-	-
	M	Resident	-	-	-	-	-	-	82	755.6	53	820.6
Secata Creek	F[2]	Unknown	-	-	-	-	-	-	38	82.0	50	227.1
	M	Resident	-	-	-	-	-	-	110	1402.8	104	1330.0
Sycamore	F	Resident	-	-	-	-	-	-	28	478.6	-	-
	M	Resident	-	-	-	-	-	-	71	1015.1	-	-
Mean[3]										733.0		712.0
S.D.										381.0		375.0

[1] Summer = 1 March to 30 September; winter = 1 October to 28 February.

[2] Secata Female was not determimed to be a resident, so her area was not included in home-range mean.

[3] Birds with 35 or fewer observations were not included in home-range means.

Table 3. Mortality data for Spotted Owls equipped with backpack-mounted transmitters, Sierra National Forest, 1987-90.

Habitat[1]	Age[2]	Sex	Date tagged M/D/Y	No. of days before death	Weight (g) Banding	Weight (g) Death	Probable cause of death
CF	Ad	F	4/29/87	230	641	---	Emaciation
CF	Ad	M	5/04/87	40	571	---	Unknown
CF	Ad	F	5/06/87	379[3]	601	---	Unknown
CF	SA	M	5/12/87	332[4]	532	370	Emaciaton, eye abcess
CF	Ad	F	6/04/87	844[5]	621	---	Unknown
CF	SA	M	6/16/87	224	522	---	Predation
OW	Ad	F	4/27/88	106	641	---	Predation
OW	Ad	F	5/16/89	36	689	---	Unknown
OW	SA	F	5/23/89	49	635	---	Uknown
OW	SA	M	12/04/89	195	635	---	Unknown
OW	Ad	M	1/08/90	237	551	---	Unknown

1 CF = Conifer forest; OW = Oak woodland
2 Ad = Adult--minimum of 3 yrs old based on tail shape (Forsman 1981)
3 Died 32 days after being fitted with a new radio.
4 Died 37 days after being fitted with a new radio.
5 Died 90 days after being fitted with a new radio.

Table 4. Comparison of the areas of habitat types (canopy-cover classes) available with the number of owl locations in each type in oak woodlands of the western Sierra Nevada foothills during the winter period of 1 October 1989 through 28 February 1990.

	Total areas (in acres) and numbers of observations						Percentages of areas and observations							
	Canopy cover						Canopy cover							
	70%+		40-69%		0-39%		70%+		40-69%		0-39%			
Bird	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Chi-square	P
Camp Male	122.0	92	42.0	10	19.3	1	66.5	89.3	22.9	9.7	10.6	1.0	24.80	<0.005
Camp Female	200.8	75	160.3	18	240.7	8	33.4	74.3	26.6	17.8	40.0	7.9	79.59	<0.005
Kirch Male	147.2	40	215.3	36	223.1	14	25.1	44.4	36.8	40.0	38.1	15.6	25.64	<0.005
Kirch Female	112.4	30	269.5	55	371.6	27	14.9	26.8	35.8	49.1	49.3	24.1	30.63	<0.005
Secata Male	36.5	8	545.4	71	748.0	25	2.7	7.7	41.0	68.3	56.2	24.0	47.31	<0.005
Secata Female	45.8	27	13.4	1	167.7	22	20.2	54.0	5.9	2.0	73.9	44.0	35.59	<0.005
Linda Male	154.7	23	652.7	30	13.1	0	18.9	43.4	79.5	56.6	1.6	0	21.28	<0.005
Mean	117.1		271.2		254.80		25.9	48.6	35.5	34.7	38.5	16.6		
SD	59.1		243.3		251.5		20.2	27.5	22.6	25.2	25.2	15.5		

Table 5. Comparison of the areas of habitat types (canopy-cover classes) available with the number of owl locations in each type in oak woodlands of the western Sierra Nevada foothills during the winter period of 1 October 1989 through 28 February 1990. "Overlap" includes only the area shared between home ranges of the members of a pair.

	Total areas (in acres) and numbers of observations						Percentages of areas and observations							
	Canopy cover						Canopy cover							
	70%+		40-69%		0-39%		70%+		40-69%		0-39%			
Birds	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Chi-square	P
Camp pair	200.1	167	160.4	28	249.9	9	32.8	81.9	26.3	13.7	40.9	4.4	229.2	<0.005
Kirch pair	195.9	70	334.1	91	470.1	41	19.6	34.7	33.4	45.0	47.0	20.3	62.13	<0.005
Secata pair	45.8	35	552.5	72	805.2	47	3.3	22.7	39.4	46.8	57.4	30.5	200.02	<0.005
Pair mean	147.3		349.0		508.0		18.5	46.4	33.0	35.2	48.4	18.4		
SD	87.9		196.0		280.0		14.7	31.3	6.5	18.6	8.3	13.1		
Camp overlap	129.3	161	43.0	22	10.3	0	70.5	88.0	23.9	12.0	5.6	0.0	28.9	<0.005
Kirch overlap	63.7	63	150.7	67	124.6	14	18.8	43.8	44.4	46.5	36.8	9.7	76.34	<0.005
Secata overlap	36.5	31	6.4	0	10.5	21	23.8	59.6	4.2	0	72.0	40.4	37.38	<0.005
Overlap mean	76.5		66.7		48.5		37.7	63.8	24.2	19.5	38.1	16.7		
SD	47.7		75.0		65.9		28.5	22.4	20.1	24.1	33.2	21.1		

Table 6. Comparison of the areas of habitat types (canopy-cover classes) available with the number of owl locations in each type in mixed-conifer forests of the western Sierra Nevada during the winter period of 1 October 1989 through 28 February 1990 for resident spotted owls.

	Total areas (in acres) and numbers of observations						Percentages of areas and observations							
	Canopy cover						Canopy cover							
	70%+		40-69%		0-39%		70%+		40-69%		0-39%			
Bird	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Chi-square	P
Exchequer Male	572.6	15	1352.3	37	142.8	1	27.7	28.3	65.4	69.8	6.9	1.9	2.03	>0.1
Exchequer Female	533.4	15	1619.9	49	141.2	2	23.2	22.7	70.6	74.2	6.2	3.0	1.13	>0.1
Providence Male	449.2	9	2505.1	35	687.5	6	12.3	17.3	68.8	67.3	18.9	11.5	2.54	>0.1
Strawberry Male	958.7	32	1589.9	40	331.6	6	33.3	41.0	55.2	51.3	11.5	7.7	2.66	>0.1
Mean	628.0		1767.0		326.00		24.1	27.3	65.0	65.6	11.1	6.0		
SD	226.0		507.0		257.0		8.9	10.2	6.8	9.9	6.3	4.4		

Table 7. Comparison of the areas of habitat types (canopy-cover classes) available with the number of owl locations in each type in mixed-conifer forests of the western Sierra Nevada during the winter period of 1 October 1989 through 28 February 1990. "Overlap" includes only the area shared between home ranges of the members of a pair.

	Total areas (in acres) and numbers of observations						Percentages of areas and observations							
	Canopy cover						Canopy cover							
	70%+		40-69%		0-39%		70%+		40-69%		0-39%			
Birds	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Chi-square	P
Exchequer pair	607.2	30	1762.6	86	211.6	3	23.5	25.2	68.3	72.3	8.2	2.5	5.07	<0.05
Exchequer overlap	498.7	29	1210.2	75	72.4	1	28.1	27.6	67.9	71.4	4.1	1.0	2.58	<0.1

Table 8. Comparison of the areas of habitat types (canopy-cover classes) available with the number of owl locations in each type in mixed-conifer forests and oak woodland forests of the western Sierra Nevada for a full year period (1 March through 1 March). "Overlap" includes only the area shared between home ranges of the members of a pair.

	Total areas (in acres) and numbers of observations						Percentages of areas and observations							
	Canopy cover						Canopy cover							
	70%+		40-69%		0-39%		70%+		40-69%		0-39%			
Pairs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Area	Obs	Chi-square	P
Exchequer (1987)	616.0	146	2428.0	239	596.0	19	16.9	36.1	66.7	59.2	16.4	4.7	125.5	<0.005
Providence (1987)	1704.0	26	5142.0	317	1499.0	29	20.4	7.0	61.6	85.2	18.0	7.8	87.87	<0.005
Exchequer (1989)	652.0	83	2276.0	135	373.0	13	19.8	35.9	69.0	58.4	11.2	5.7	40.55	<0.005
Pair mean	991.0		3282.0		823.0		19.0	26.3	65.8	67.6	15.2	6.1		
SD	618.0		1613.0		596.0		1.9	16.7	3.7	15.3	3.6	1.6		
Camp 4-1/2 (1989)*	222.0	283	181.0	47	270.0	26	33.0	79.5	26.9	13.2	40.1	7.3	353.41	<0.005
Kirch (1989)*	191.0	126	502.0	180	250.0	40	20.3	36.4	53.2	52.0	26.5	11.6	73.53	<0.005
Pair mean	206.0		342.0		260.0		26.6	57.9	40.0	32.6	33.3	9.5		
SD	21.9		227.0		14.1		8.9	30.5	18.6	27.4	9.6	3.0		
Exch. overlap (87)	463.0	144	1943.0	217	404.0	15	16.5	38.3	69.2	57.7	14.3	4.0	143.65	<0.005
Prov. overlap (87)	221.0	19	1692.0	261	388.0	14	9.6	6.5	73.5	88.8	16.9	4.7	37.97	<0.005
Exch. overlap (89)	516.0	78	1326.0	123	151.0	9	25.9	37.1	66.5	58.6	7.6	4.3	15.26	<0.005
Overlap mean	400.0		1654.0		314.0		17.3	27.3	69.7	68.4	12.9	4.3		
SD	157.3		310.0		141.7		8.2	18.0	3.5	17.7	4.8	0.3		
Camp. overlap (89)*	186.0	281	74.0	43	75.0	13	55.5	83.4	22.1	12.8	22.4	3.8	112.3	<0.005
Kirc. overlap (89)*	160.0	112	354.0	145	127.0	23	25.0	40.0	55.2	51.8	19.8	8.2	44.74	<0.005
Overlap mean	173.0		214.0		101.0		40.2	61.7	38.6	32.3	21.1	6.0		
SD	18.4		198.0		36.8		21.6	30.7	23.4	27.6	1.8	3.1		

Table 9. Home-range sizes (acres) of male and female spotted owls during the summer season (1 March - 30 September) in mixed-conifer forests of the Sierra National Forest, based on data from 1987, 1988, and 1989. For birds sampled in more than 1 year, means of pooled yearly values are tabulated here.

	By canopy-cover class					
	70% or more	40-69%	39% or less	Total area	Total with 40% or greater canopy cover	Number of years sampled
MALES						
Dinkey	102	2045	1278	3425	2147	1
Exchequer	431	1497	299	2227	1928	2
Laurel	99	1902	841	2842	2001	1
Markwood	354	872	707	1933	1226	1
Providence	215	2020	570	2805	2235	2
Stevenson	508	512	619	1639	1020	1
Strawberry	246	1304	205	1755	1550	3
Laurel	331	2185	360	2876	2516	2
Reese	322	1494	881	2697	1816	2
Mean	290	1537	640	2467	1827	
FEMALES						
Dinkey	177	2278	2134	4589	2455	1
Exchequer	302	957	173	1432	1259	2
Providence	21	1359	342	1722	1380	3
Stevenson	519	1373	1646	3538	1892	3
Bear Mdw	951	3626	558	5135	4577	1
Laurel	228	1740	266	2234	1968	1
Strawberry	290	1275	256	1821	1565	1
Reese	163	1314	1200	2677	1477	1
Mean	331	1740	822	2893	2072	
Combined mean	309	1633	726	2677	1942	

Table 10. Home-range sizes (acres) of pairs during the summer period (1 March - 30 September:), and percentages of pair home ranges used by each sex, based on pairs with >35 observations for each sex.

Pair	Total area used by pair	Male		Female		Number of years sampled
		Area used	Percent of pair area	Area used	Percent of pair area	
Dinkey	5555	3425	61.7	4589	82.6 (2459.0) shared	1
Exchequer	2385	2227	93.4	1433	60.0 (1275.0)	2
Providence	3038	2805	92.3	1525	50.2 (1292.0)	2
Stevenson	3745	1639	43.9	3372	90.0 (1266.0)	1
Laurel	4650	4126	88.7	2234	48.0 (1710.0)	1
Strawberry	2527	2072	82.0	1821	72.1 (1366.0)	1
Reese	3085	2436	73.5	2677	86.8 (2029.0)	1
Mean	3569	2675	75.0	2521	70.0	

Table 11. Summary data on summer-season (1 March - 30 September) and year-long home ranges of individuals and pairs in the mixed-conifer forest, in relation to suitable habitat provided in Regional Standards and Guides for Spotted Owl Habitat Areas (SOHAs) in the Sierra Nevada. Only birds with >35 locations have been used. Areas expressed in acres.

	Area (acres)	SD	Percent of observed home ranges provided by SOHAs: Suitable habitat (1000 acres)	Percent of observed home ranges provided by SOHAs: Suitable plus replacement habitat (1650 acres)
INDIVIDUAL OWLS, SUMMER SEASON (n = 17)				
Total home range	2677	1035	37.4	61.6
70+% canopy cover	309	215		
40-69% canopy cover	1633	703		
0-39% canopy cover	726	555		
40+% canopy cover	1942	804	51.5	85.0
PAIRED OWLS, SUMMER SEASON (n = 7)				
Total home range	3569	1165	28.0	46.2
70%+ canopy cover	455	196		
40-69% canopy cover	2079	760		
0-39% canopy cover	1035	739		
40%+ canopy cover	2534	845	39.5	65.1
PAIRED OWLS, YEARLONG (n = 2)				
Total home range	5920	3429	16.9	27.9
70%+ canopy cover	1169	757		
40-69% canopy cover	3759	1956		
0-39% canopy cover	992	717		
40%+ canopy cover	4928	712	20.2	33.5

Table 12. Classification of habitat types and grouping levels used in data analysis.

Vegetative layer/stage			CODE
OVERSTORY COVER TYPE			
	Individual tree species are identified if they dominate more than 90% of the stand within a polygon.	Incense cedar	LIDE
		Lodgepole pine	PICO
		Ponderosa pine	PIPO
		Jeffery pine	PIJE
		Sugar pine	PILA
		White fir	ABCO
		Red fir	ABMA
		Oak species	QUSP
	Where stands are a mixture of tree species in a polygon.	Mixed-conifer	MC
SUCCESSIONAL STAGE			
Saplings	Shrubs and saplings over 6.5 feet tall with a DBH = 1 to 4.7 inches (2 to 12 cm).		1
Pole	Pole size trees with a DBH of 4.8 to 10.6 inches (13 to 27 cm).		2
Young	Medium-sized trees with a DBH of 10.7 to 20.5 inches (28 to 52 cm).		3
Mature	Large mature trees with a DBH of 20.6 to 35.4 inches (53 to 90 cm).		4
Old	Mature and old trees with a DBH of 35.5 inches or larger (>91 cm)		5
CANOPY COVER CLASS			
0-39% canopy cover			A
40-69% canopy cover			B
70+% canopy cover			C

Table 13. Dominant, subdominant, and understory vegetation and groundcover types within Spotted Owl home ranges in the Sierra National Forest, 1987-90.

Dominant vegetation type	Subdominant tree stage	Understory or grouncover	Total polygons in all owl home ranges	Number of polygons sampled
MC-5A	2	Rock	1	1
	2	Shrub	1	1
	2	Rock and shrub	1	1
	3	Rock	1	1
	3	Shrub	1	1
MC-5B	2	Shrub	1	1
	3	Litter	4	4
MC-5C	3	Shrub	2	2
	3	Litter	5	4
MC-4A	2	Rock	1	1
	3	Rock	5	4
	3	Shrub	3	3
	3	Meadow	6	4
	3	Litter	6	4
	3	Rock and shrub	1	1
MC-4B	3	Shrub	2	2
	3	Litter	17	5
	3	Rock and shrub	1	1
MC-4C	2	Litter	1	1
	3	Litter	5	4
MC-3A	2	Shrub	1	1
	2	Litter	4	4
	4	Rock	31	3
	4	Shrub	20	3
	4	Meadow	8	4
	4	Litter	7	3
	4	Rock and shrub	12	4
	5	Rock	8	4
	5	Shrub	5	4
	5	Meadow	1	1
	5	Litter	2	2
MC-3B	4	Rock	1	1
	4	Shrub	10	4
	4	Litter	43	5
	4	Rock and shrub	4	4
	5	Shrub	11	4
	5	Litter	13	4
MC-3C	4	Shrub	1	1
	4	Litter	7	4
	5	Shrub	2	2
	5	Litter	1	1

Table 13, cont'd.

Dominant vegetation type	Subdominant tree stage	Understory or grouncover	Total polygons in all owl home ranges	Number of polygons sampled
MC-2A	3	Shrub	1	1
	3	Litter	3	3
	4	Litter	2	2
	4	Rock and shrub	1	1
	5	Rock	1	1
MC-2C	3	Litter	1	1
	4	Litter	1	1
No trees	-	Meadow	1	1
Total			267	120

[1] Rock = 50% or more of the ground surface is rock; shrub = 50% or more of the understory is dominated by woody species less than 3 m tall; shrub/rock = any combination of shrubs and rocks equal to 60% or more of the understory or ground surface; meadow = 45% or more of the unederstory vegetation composed of grass or herbaceous vegetation; litter = ground survace covered by dead woody material or soil.

Table 14. Mean density (stems/acre) and basal area (ft^2/acre) of conifers and hardwoods by diameter class (inches) for trees, and for snags >4.8 inches in diameter; mean number and diameter of downed logs >4.8 inches in diameter, measured along a 330-ft line intercept; mean number of shrubs per acre >6.5 ft tall; and mean percent canopy cover (and standard deviation), based on aerial photo interpretation and spherical densiometer measurements.

Diameter class	MC2A		MC3A		MC4A		MC5A		MC3B		MC4B		MC5B		MC2C		MC3C		MC4C		MC5C	
	#/A	BA	#/A	BA	#/A	BA	#/A	BA	#/A	BA	#/A	BA	#/A	BA	#/A	BA	#/A	BA	#/A	BA	#/A	BA
LIVE CONIFERS																						
35.5+	0.5	5.0	1.0	13.7	1.0	11.9	1.2	13.0	3.8	43.7	3.9	47.9	4.8	54.9	2.0	26.9	3.3	40.3	4.8	69.5	4.4	58.1
20.6-30.4	4.6	17.8	5.0	22.0	5.5	21.5	9.9	38.1	14.1	59.7	16.7	66.2	18.6	74.0	3.0	8.9	24.3	94.2	20.8	83.2	16.7	61.0
10.7-20.5	9.9	11.0	12.5	15.5	12.5	15.7	14.2	20.5	30.8	38.7	27.8	32.4	40.9	54.1	61.7	67.3	43.8	56.7	37.2	42.8	45.2	57.0
4.8-10.6	43.8	14.8	22.0	6.5	18.8	6.3	12.9	3.6	44.4	14.0	29.8	9.7	63.1	19.8	66.8	22.8	50.0	16.8	63.9	19.6	91.1	27.9
1.0- 4.7	34.1	1.9	50.0	2.1	22.9	1.1	39.3	1.5	102.0	4.1	76.1	3.1	71.6	3.0	69.8	3.3	56.9	2.2	98.7	4.7	197.9	7.6
Total	92.8	50.5	90.6	59.7	60.6	56.6	77.3	75.5	195.1	160.2	154.2	159.3	199.1	205.8	203.3	129.2	178.0	160.2	225.6	219.8	354.9	211.8
LIVE HARDWOODS																						
35.5+	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
20.6-35.4	0.5	1.5	0.1	0.4	0.1	0.3	0.4	1.2	0.4	1.4	0.0	0.0	0.8	2.7	0.0	0.0	0.5	1.6	0.0	0.0	0.3	1.0
10.7-20.5	1.5	1.4	0.9	0.9	1.5	1.6	0.8	0.7	2.7	2.8	0.3	0.2	0.4	0.9	2.0	3.4	1.3	1.1	1.2	1.3	1.4	4.8
4.8-10.6	2.5	1.1	1.5	0.6	0.8	0.3	5.3	1.9	5.5	1.9	1.5	0.5	2.4	1.1	2.0	0.7	4.3	1.5	4.0	1.2	3.3	3.9
1.0- 4.7	2.3	0.1	2.8	0.1	5.9	0.1	16.2	0.4	10.3	0.3	3.3	0.1	12.9	0.2	1.0	0.1	19.5	0.4	4.0	0.1	4.4	1.3
Total	6.8	4.0	5.3	2.2	8.5	2.3	22.7	4.2	18.9	7.5	5.1	0.7	16.6	4.9	5.1	4.1	25.5	4.6	9.3	2.7	12.6	11.9
All trees	99.7	54.5	95.9	61.9	69.1	58.9	100.2	79.8	213.7	167.7	159.5	160.0	215.7	210.7	208.4	133.3	203.9	214.7	234.0	222.6	391.5	223.6
CONIFER SNAGS	0.7	2.3	3.2	4.8	5.2	4.8	2.6	1.9	8.5	10.2	4.8	9.1	23.8	18.3	2.2	1.5	15.6	13.1	13.6	15.8	12.1	13.7
SHRUBS	1.3	-	1.8	-	6.2	-	11.3	-	24.0	-	3.5	-	15.0	-	42.5	-	1.5	-	0.0	-	13.2	-
DOWNED LOGS	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.	#	Mean diam.
	1.4	19.1	2.4	16.1	1.6	12.1	1.7	14.0	3.5	13.3	3.5	20.0	3.5	13.6	3.3	13.5	4.3	13.8	3.9	12.9	4.9	16.2
CANOPY COVER	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Aerial p.i.	19.9	10.4	23.4	10.6	15.4	9.2	24.4	8.4	52.7	9.6	51.0	8.4	56.4	5.0	70.5	10.4	76.9	5.6	71.8	2.2	75.2	5.5
Densiometer	26.8	16.5	24.6	13.4	28.6	25.3	30.7	20.4	59.7	15.7	55.5	10.3	68.8	11.9	70.3	0.3	72.0	10.1	68.6	10.8	80.7	8.8

Table 15. Sizes (square miles) of demographic study areas and major habitat therein. Ranges in elevation (in feet) are shown in parentheses below habitat designations.

	Total	Oak woodland (1000-4000)	Mixed-conifer forest (4000-8000)	Red fir and lodgepole pine forest (8000-9600)
Sierra National Forest	161	50	96	15
Sequoia/Kings Canyon National Parks	132	32	89	11

Table 16. Results of initial year of demographic studies in the Sierra National Forest (SNF) and Sequoia/Kings Canyon National Parks (SNP).

Study area	Adults and subadults: Located	Adults and subadults: Banded[1]	Pairs confirmed	Nesting confirmed	Number of young: Located	Number of young: Banded	Crude density of adults and subadults[2]
SNF	85	56	37	18 (49%)	22	15	0.53/mi^2
SNP	67	30	25	13 (52%)	21	15	0.51/mi^2

[1] Total banded by the end of the 1990 field season, including birds banded in prior years.

[2] Crude density = total number of adults and subadults divided by the total study area.

Table 17. Measurements of male and female Spotted Owls from western slopes of the southern Sierra Nevada.

	Male			Female			Males vs females	
	n	Mean	SD	n	Mean	SD	F	P
Weight (g)	47	549.8	32.8	44	625.2	43.5	88.00	<0.001
Tail bars	42	6.6	1.2	37	7.5	1.1	9.82	=0.002
Bill depth (mm)[1]	32	17.3	1.2	29	18.2	1.4	7.34	=0.009
Wing cord (mm)	42	316.1	9.8	37	320.9	12.9	3.58	=0.062
Tail length (mm)	42	211.7	11.1	37	216.2	14.5	2.44	=0.123
Tarsus length (mm)	42	59.0	5.8	37	60.6	7.7	1.17	=0.282
Bill length (mm)	31	23.2	3.9	27	22.7	1.7	0.36	=0.550

[1] Sierra forest owls only.

Table 18. Weights (grams) of Spotted Owls from high-elevation (above 4000 feet) and low-elevation (below 4000 feet) sites on the western slopes of the southern Sierra Nevada.

		Low elevation			High elevation			High vs low	
Sex	Study area	n	Mean	SD	n	Mean	SD	F	P
Male	Sierra NF	9	573.4	34.7	28	544.8	29.1	5.12	0.030
	Sequoia/Kings Canyon NPs	0			10	542.5	34.6		
Female	Sierra NF	10	652.7	43.7	26	617.6	41.0	6.03	0.019
	Sequoia/Kings Canyon NPs	0			8	615.6	41.8		

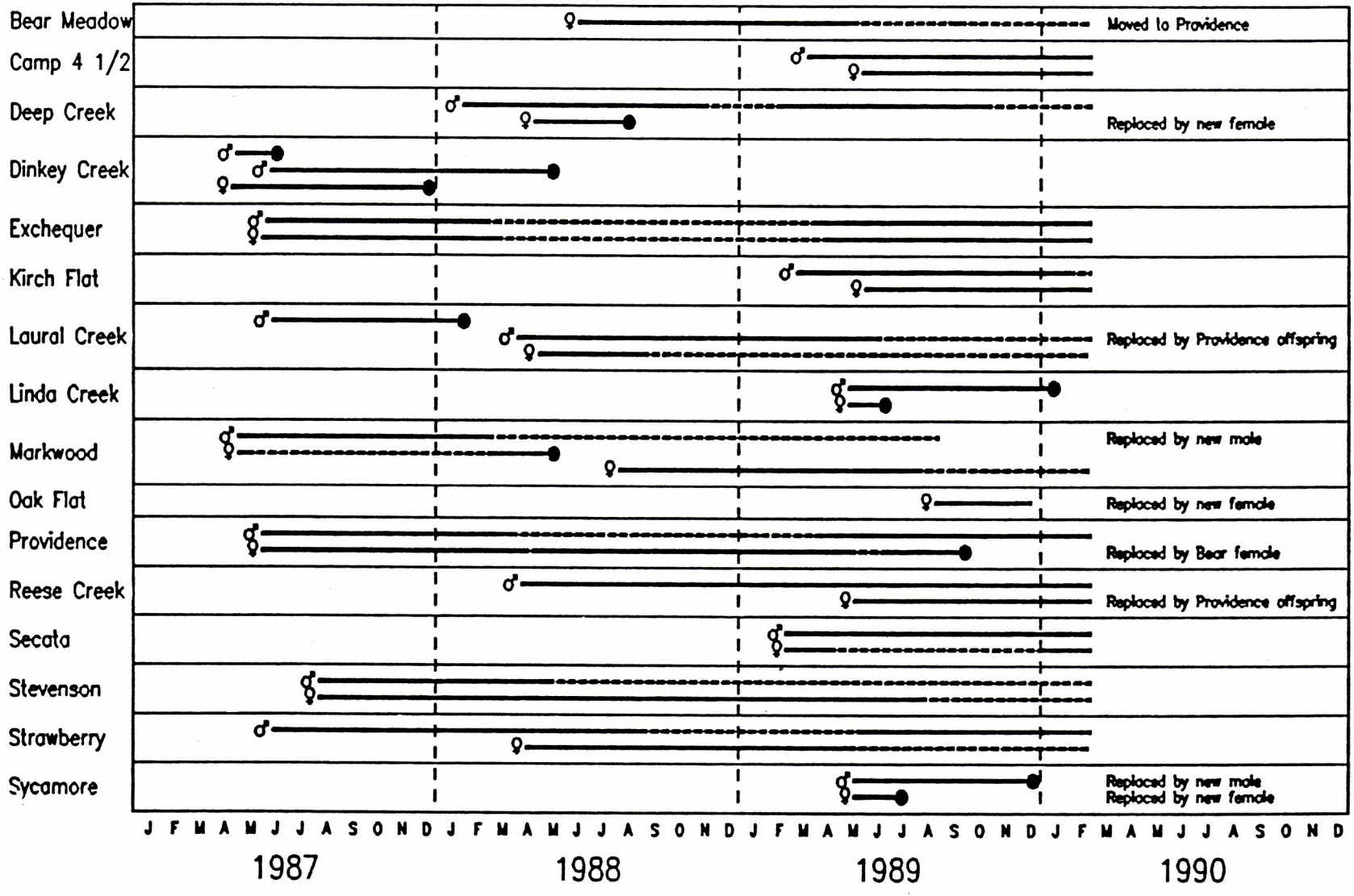


Figure 1. Chronology of radio-tracking periods for Spotted Owls in the Sierra National Forest study area, 1987-1990. Solid lines designate periods when radios were active; dashed lines designate periods when radios were inactive. Dots indicate confirmed deaths of owls.

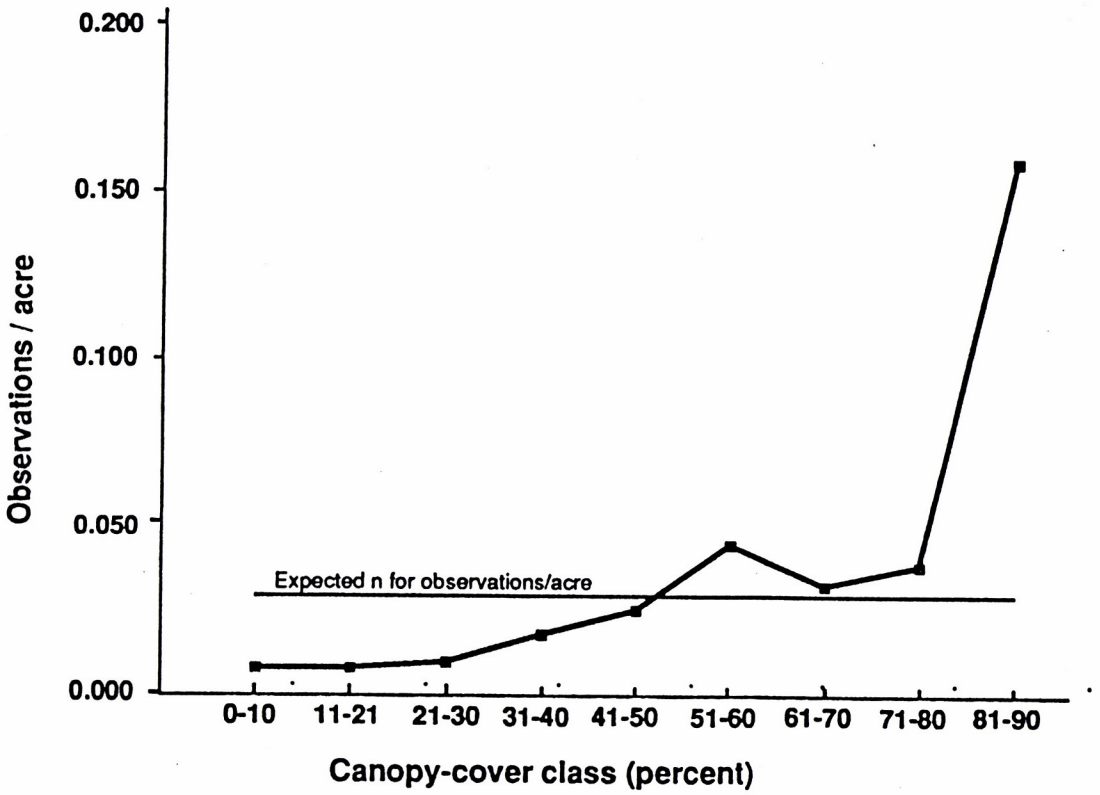
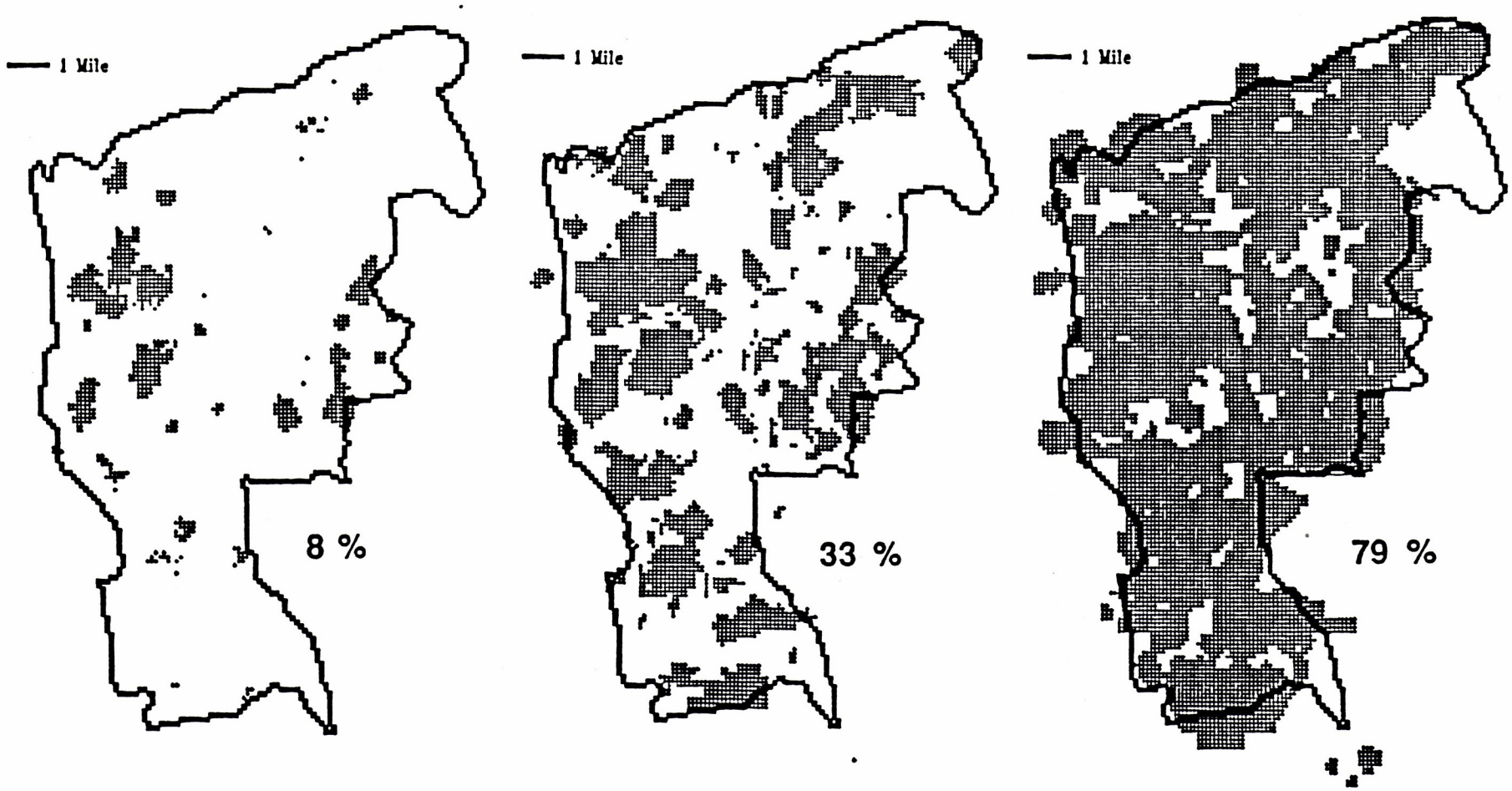


Figure 2. Habitat use vs habitat availability, based on owl locations per acre in relation to canopy-cover classes by 10-percentage increments. The horizontal line designates the expected number of locations per acre if all acres are used in proportion to their availability.

Figure 3. Map of California, with demographic study areas shaded.



Area surveyed 6 or more times.

Area surveyed 3 or more times.

Area surveyed 1 or more times.

Figure 4. Maps of the demographic study area in Sierra National Forest, showing three levels of survey effort accomplished in the 1990 field season.

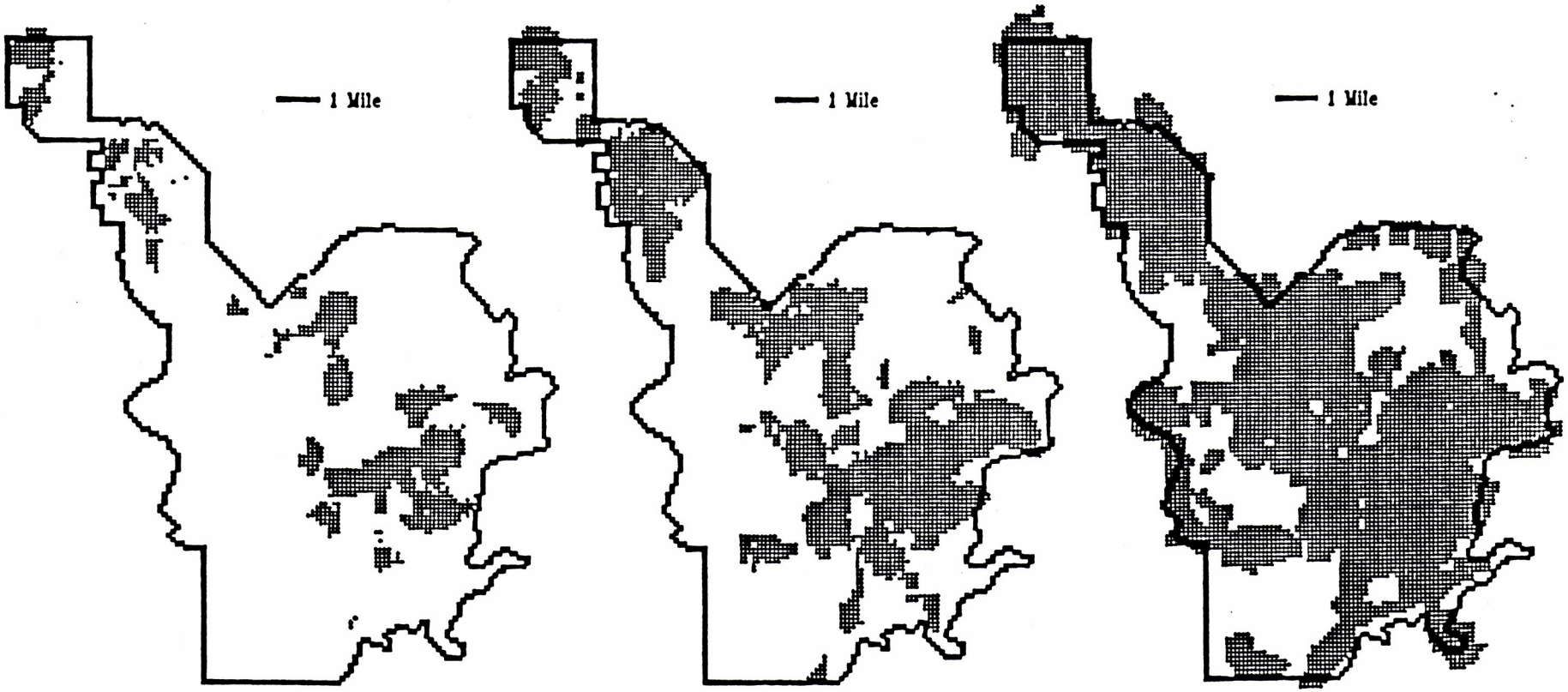


Figure 5. Maps of the demographic study area in Sequoia/Kings Canyon National Parks, showing three levels of survey effort accomplished in the 1990 field season.

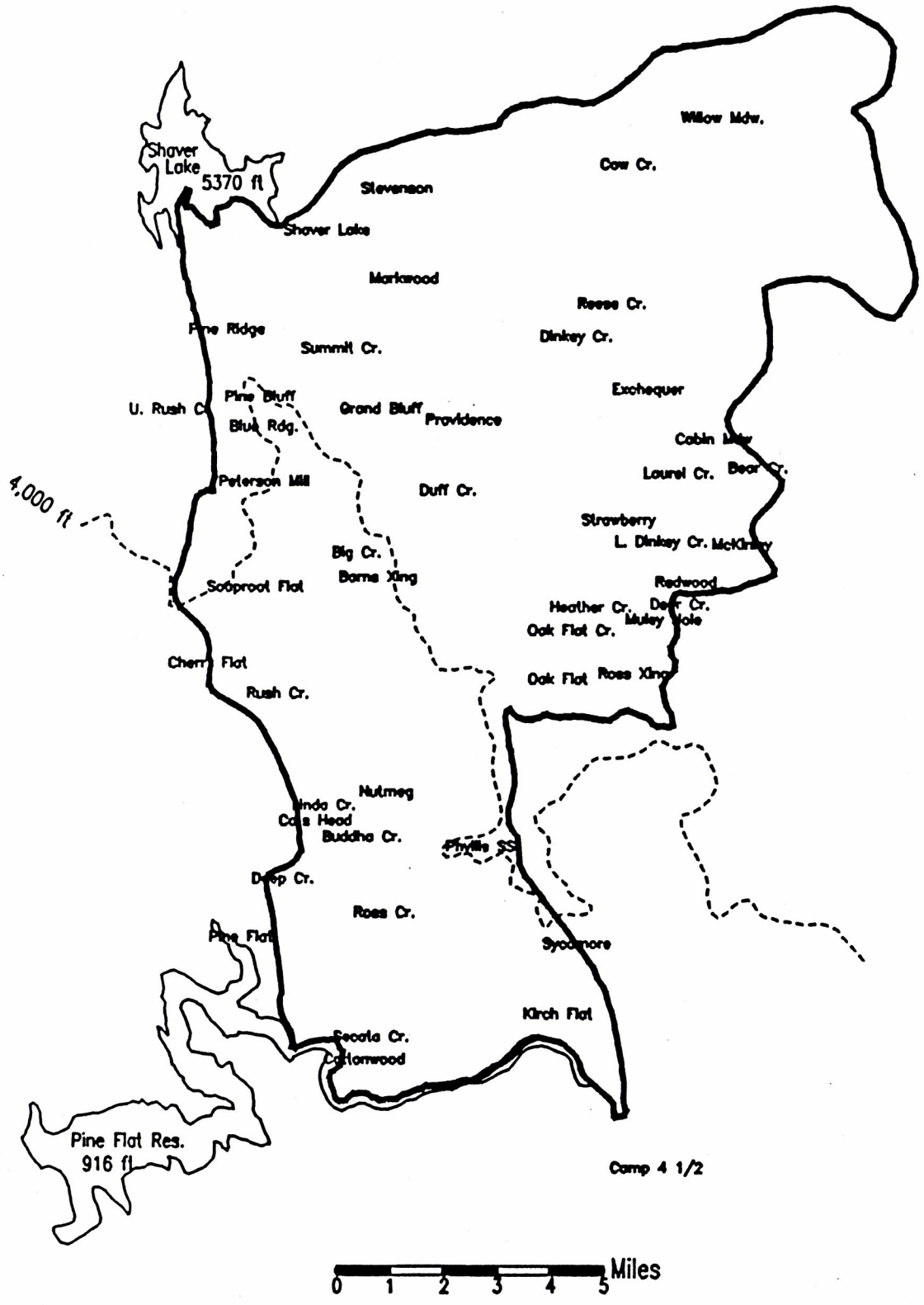


Figure 6. Map of the demographic study area in the Sierra National Forest, showing approximate locations of various sites referred to in the text.

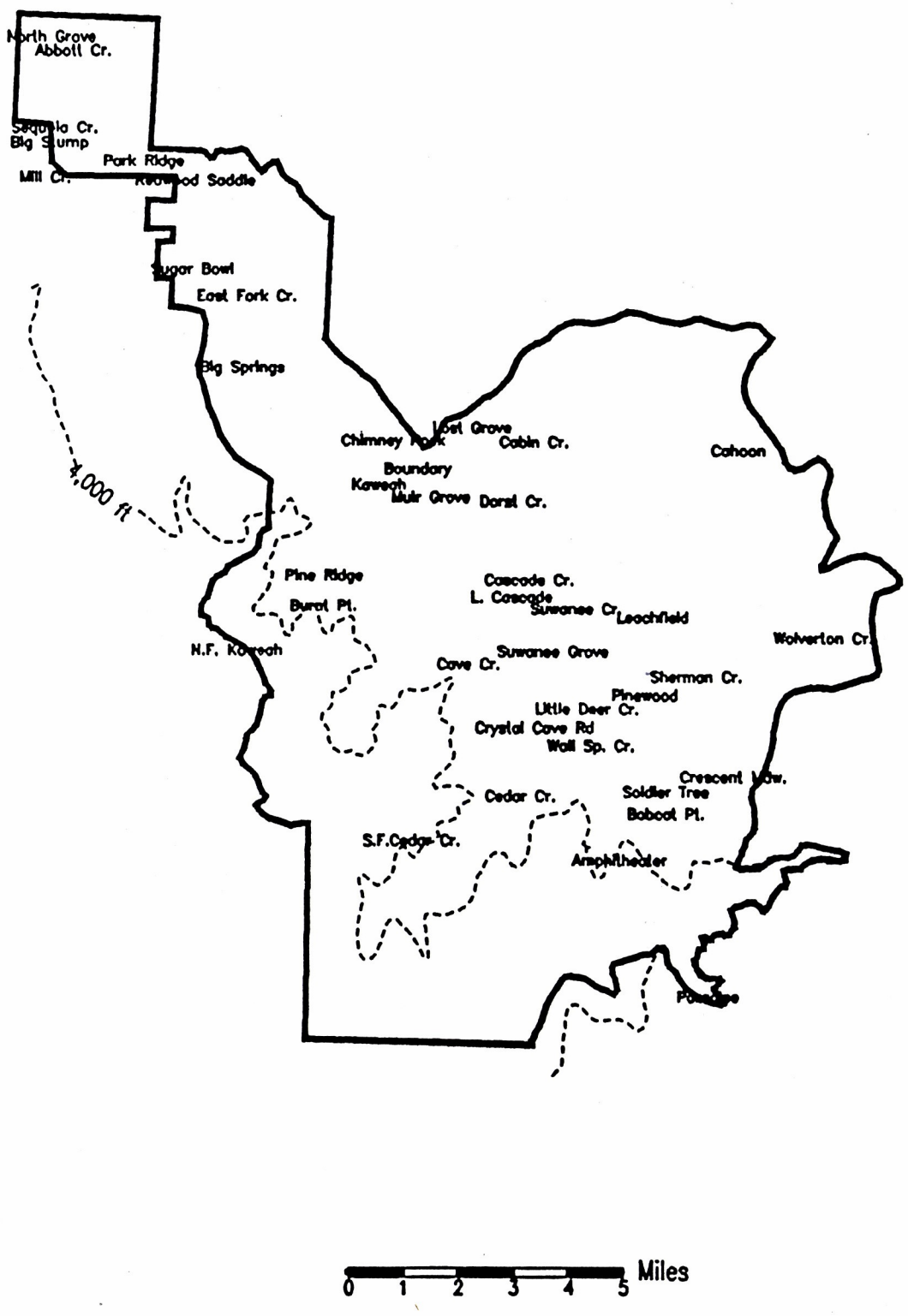


Figure 7. Map of demographic study area in Sequoia/Kings National Parks, showing approximate locations of various sites referred to in the text.